Measurement of neutron inelastic scattering cross sections for ^{209}Bi from threshold up to 18 MeV

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The investigation of inelastic scattering of neutrons on structure materials used for the design of the new generation of reactors was continued at Gelina facility with ^{209}Bi. The interest for ^{209}Bi, the only one stable isotope of bismuth, is motivated for instance by its possible use in the spallation module and the moderator/coolant of an accelerator driven system (ADS). Inelastic scattering contributes with about 30% to the total neutron cross-section of ^{209}Bi. It was recently demonstrated that uncertainties of the lead and bismuth inelastic scattering cross sections produce a 2% uncertainty in k_{eff} for an ADS. This motivates a detailed study to obtain better precision data for inelastic scattering. Here new data are presented for continuous energy gamma-ray production cross sections up to about 18 MeV. From these total and level inelastic cross sections are deduced. The new continuous energy and high resolution data completely fix the inelastic scattering cross sections in the first few MeV above the threshold, which is of particular importance to applications. The data at higher energy are valuable for benchmarking of model calculations.

The white neutron beam, produced by bombarding a rotary uranium target with electrons of a nominal energy of 105 MeV and an average current of $70\mu A$, is scattered inelastically by a metallic sample of ^{209}Bi. The γ-rays from the reaction $^{209}\mathrm{Bi}(n,n'\gamma)^{209}\mathrm{Bi}$ are detected with two large volume HPGe detectors placed at 110^o and 150^o with respect to the beam direction. These angles are the roots of the fourth order Legendre polynomial which allows to make the correction for angular distribution, the error being negligible, in the contribution of the 8^{th} order Legendre polynomial.

The absolute efficiency of the HPGe detectors has been measured with standard point-like calibration sources and, by means of MCNP simulations, the correction for the gamma ray self-attenuation in the real ^{209}Bi target as well as for the effect of extended volume source has been determined.

The neutron flux has been measured with a multilayer ^{235}U fission chamber. The measurements were done at the 200 m time-of-flight path at 800 Hz repetition rate of the neutron burst. For the main transitions the inelastic cross-section is given with an incident neutron energy resolution ranging from 1.1 KeV at 1 MeV to 35.7 KeV at 10 MeV, the overall statistical error being less than 5%. Gamma rays which decay from levels up to about 3.1 MeV excitation energy were observed. Based on the known level scheme of ^{209}Bi lower limits for level and total inelastic cross-sections are constructed. The results will be compared with existing experimental data. Earlier, results have been obtained for ^{52}Cr and ^{58}Ni with the same setup and methodology.

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